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[Claim(s)]
[Claim 1]An air-conditioner for vehicles characterized by comprising the following which carries out the optimal control of said air-conditioning control element so that the amount of control of two or more air-conditioning control elements may be computed based on two or more physical quantity related with heat load and vehicle room temperature may be converged on set-up target temperature.
As opposed to space which divided the vehicle interior of a room into two or more control space, and formed a room temperature sensor in the one space at least and in which said room temperature sensor was formed, The thermal characteristic which added correction to a dynamic model corresponding to the space concerned according to a difference of estimated temperature of the space, and space temperature detected by a room temperature sensor, and said physical quantity was presumed, and was decided in a relation with other space to space in which said room temperature sensor is not formed.
Said room temperature sensor.

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention processes two or more physical quantity related with the heat load containing measurement difficulty or the physical quantity which cannot be measured based on modern control theory, and computes the amount of optimal control of air-conditioning control elements, such as a temperature control means, the amount regulation means of winds, and a blow-off mode regulation means, It is related with the air-conditioner for vehicles which completes vehicle room temperature as the set-up target temperature.
[0002]
[Description of the Prior Art]As an air-conditioner for vehicles which air-conditions vehicle room temperature to target temperature using modern control theory, what is shown in JP,H5-50836,A, for example is publicly known. This computes the desired value of physical quantity (vehicle room temperature and skin temperature) which should be made to change in time based on a vehicle room temperature preset value among the physical quantity about heat load required for air-conditioning control, Compute the optimal control constant for presuming the state variable by which the internal

state of the dynamic model about air-conditioning is denoted from the amount of control and vehicle room temperature to a controlled object, and following said desired value, and. Based on a desired value, a presumed state variable, and vehicle room temperature, the amount of optimal control to a controlled object is determined, and this secures a response and stability to all environment.

[0003]If it explains more concretely, [the controller used by this system] As shown in the block diagram (the same as that of drawing 2 of the gazette) of drawing 3, the intensity of radiation Qsun. It is what computes the amount of control for controlling the air-conditioning unit 10 based on the outdoor air temperature Tamb, the vehicle room temperature preset value Tptc, and the vehicle room temperature Tinc (the air mixing door opening X, the blower drive voltage Vf), Functionally, it comprises the norm model 20, the observer 30, the line type compensation machine 40, and the optimal regulator 50.

[0004]To a norm model, 20 set, and in order to make the degree To of blow-off temperature and the amount Ga of blow-off winds by the air-conditioning unit 10 change so that a crew member's comfortable feeling may be suited, [the amount] Based on the equation of state shown with the expression 1, target vehicle room temperature $Tinc^*$ and target skin temperature Tf^* which suited the comfortable feeling of the crew member when changing the vehicle room temperature preset value Tptc are computed.

[0005]

[Mathematical formula 1]dXr/dt=Ar-Xr+Br-TptcYr=Cr-Xr[0006]Here, Ar, Br, and Cr are coefficient matrices and are Yr=Xr=$[Tf^*, Tinc^*]^T$.

[0007]The observer 30 Point estimate Tm^S of body temperature, point estimate $Tinc^S$ of vehicle room temperature, State variable Xo^S (=$[Tm^S, Tinc^S, Ga^S, Xmm^S]^T$) which consists of point estimate Ga^S of the quantity of the blow-off style and point estimate Xmm^S of an air mixing door opening is presumed, Based on point estimate Tm^S of body temperature, point estimate Ga^S of the quantity of the blow-off style, and point estimate Xmm^S of an air mixing door opening, present skin temperature point estimate Tf^S is predicted among the presumed state variables.

[0008]And in the optimal regulator 50, in the system which took into consideration the line type-ized compensation with the line type compensation machine 40 using the valuation function J shown in the expression 2, a deviation with a desired value and the rate of change of the amount of control are computed, and the amount U of control of the air-conditioning unit 10 which makes the valuation function J the minimum is determined.

[0009]

[Mathematical formula 2]J=integral {W1, ^{2}+W2, ^{2}+W3, ^{2}+W4, and$(du2/dt)^2$} dt [0010]deltaTint here The deviation from desired value $Tinc^*$ of vehicle room temperature, The rate of change of the command value as which deltaTf determines the deviation from desired value Tf^* of skin temperature, and du1/dt determines the blower drive voltage Vf (the amount Ga of blow-off winds), and du2/dt express the rate of change of a command value which determines the air mixing door opening X (blow-off temperature To), and W1-W4 are dignity coefficients.

[0011]And in the determination of the amount U of control (u1, =$[u2]^T$), an expansion system as shown in the expression 3 from the above-mentioned expression 1 and the conversion function which performs line type-ized compensation is constituted, and the control constant (K1, K2, K3) shown with the expression 4 from the control rule which makes the valuation function J the minimum in this expansion system is determined.

[0012]
[Mathematical formula 3]dE/dt=Ae-E+Be-dU/dt[0013]
[Mathematical formula 4]U=K1, Y+K2, integraledt+K3, andXr+ {U-[(0)] K1, Y(0)-K3, and Xr (0)}
[0014]Here, it is E=[dY/dt, e, dXr/dt] ^{T} and Ae and Be are a coefficient matrix and e=Yr-Y. U (0), Y (0), and Xr (0) are the initial values of a control command value, an output, and a state variable, respectively.
[0015]In such control, [an above-mentioned observer] As shown in drawing 4 (the same as that of drawing 4 of the gazette), it consists of a homogeneous dimension state observer, In order to make zero converge presumed error epsilono (=Xo^S-Xo) of a state variable on the presumed model identified beforehand to the equation of state (expression 5) of a controlled object, feedback is added and the model of the expression 6 is formed.
[0016]
[Mathematical formula 5]dXo/dt=Ao-Xo+Bo-UYo=Tinc=Co-Xo[0017]
[Mathematical formula 6]dXo^S/dt=Ao-Xo^S+Bo-U+F- (Yo-Yo^S)
Yo^S=$Tinc^S$=Co-Xo^S[0018]If it is in such an observer, even if Ao is an unstable matrix, by choosing the suitable gain F, Ao-FCo is made to a stable matrix and there is an advantage which can complete presumed error epsilono (=Xo^S-Xo) as zero quickly.
[0019]
[Problem to be solved by the invention]However, in an above-mentioned system, since he is trying to approximate the vehicle interior of a room by one presumed model by an observer, it cannot be said to be thing inaccurate, when air-conditioning environment changes with solar radiations etc. by the right and left of a vehicle room, or the upper and lower sides and sufficient as model accuracy. Although such a thing it receives inconvenient and is done to the upper and lower sides, right and left, or order for the independent temperature control (individual temperature control) of the vehicle indoor space is also considered, In such a case, since the number of control space increases, though the increase in an air-conditioning control element is unavoidable, when only the number of space makes an above-mentioned system only increase. Since control which does not take into consideration the thermal correlation between other space must be performed or a room temperature sensor must be formed for every space, the number of room temperature sensors will also increase. For this reason, even if it is a case where independent control of each space is carried out, how the physical quantity about what individual control of each space is associated and carried out with few room temperature sensors and the heat load which will be used for calculation of the amount of control of an air-conditioning control element if it puts in another way should be presumed in a relation with other space poses a problem.
[0020]Then, in this invention, after being premised on the purpose of the conventional air-conditioning control of securing a response and stability under various environment, when dividing the vehicle interior of a room into two or more space and carrying out individual control, it is making into SUBJECT to provide the air-conditioner for vehicles which accuracy can improve each space temperature control control.
[0021]
[Means for solving problem]The place which carries out a deer and by which it is characterized [of this invention] computes the amount of control of two or more air-conditioning control elements based on two or more physical quantity related with heat load, In the air-conditioner for vehicles which carries out

the optimal control of said air-conditioning control element so that vehicle room temperature may be converged on the set-up target temperature, As opposed to the space which divided the vehicle interior of a room into two or more control space, and formed the room temperature sensor in the one space at least and in which said room temperature sensor was formed, According to the difference of the estimated temperature of the space, and the space temperature detected by the room temperature sensor, add correction to the dynamic model corresponding to the space concerned, and presume said physical quantity, and. It is in adding correction to the dynamic model corresponding to the space concerned to the space in which said room temperature sensor is not formed based on the thermal characteristic decided in the relation with other space, and the amount of corrections to the dynamic model of the space in which said room temperature sensor was formed, and having presumed said physical quantity.

[0022]An air-conditioning control element means the element which can control air-conditioning units, such as a temperature control means, the amount regulation means of winds, and a blow-off mode regulation means, and here, [amount / of an air-conditioning control element / of control / therefore,] An air mixing door opening (the degree of blow-off temperature), blower drive voltage (the amount of blow-off winds), the damper opening that changes blow-off mode, etc. are said. The control parameter which can be set to the physical quantity about heat load by a crew member's operation like vehicle indoor preset temperature, measurable like intensity of radiation, outside temperature, and vehicle room temperature -- being and carrying out -- measurement -- measurement difficulty or the control parameter which cannot be measured is included like the calorific capacity of an easy control parameter, body temperature, a vehicle room, or the body.

[0023]And, [as basic structure of the air-conditioner for vehicles which carries out the optimal control of the air-conditioning control element so that vehicle room temperature may be converged on the set-up target temperature] A means to generate the desired value which should be made to change in time among the physical quantity about a structure more publicly known than before, i.e., heat load, A means to presume measurement difficulty or the physical quantity which cannot be measured among the physical quantity about heat load based on the dynamic model of the system about air harmony, What is necessary is just to use the thing provided with the optimal regulator which determines the amount of optimal control of the air-conditioning control element completed as a temperature aiming at vehicle room temperature based on measurable physical quantity among the physical quantity about said desired value, presumed physical quantity, and heat load.

[0024]Therefore, if it is in a dynamic model corresponding to space in which a room temperature sensor was formed, Since a difference of estimated temperature of computed space and space temperature actually detected by a room temperature sensor is taken into consideration, physical quantity (state variable) which expresses an internal state of the dynamic model as a homogeneous dimension observer known, for example from the former is presumed with sufficient accuracy. On the other hand, a dynamic model corresponding to space in which a room temperature sensor is not formed is received, Since accuracy sufficient by having just added the amount of corrections used for a dynamic model of space which has a room temperature sensor is not acquired, physical quantity (state variable) which expresses an internal state further in consideration of the thermal characteristic decided in a relation with other space is presumed. Thereby, also in which space, physical quantity can be presumed with sufficient accuracy.

[0025]

[Mode for carrying out the invention]Hereafter, although Drawings explain this embodiment of the

invention, vehicle indoor space is divided into the upper and lower sides, right and left, or two space of order, and supposing a case where independent temperature control of each is carried out, make one side into the 1st space and let another side be the 2nd space. Since it is possible to use various air-conditioners (for example, JP,H5-50836,A etc.) using modern control theory as whole system structure, For convenience, whole system structure assumes the fundamentally same thing as JP,H5-50836,A, and, below, explains it focusing on a characterizing portion of an application concerned.
[0026]Even if the air mixing door of only the number corresponding to each space, etc. are provided in one air-conditioning unit as an air-conditioning unit and it controls each space independently, a separate air-conditioning unit corresponding for every space may be provided.
[0027]By the way, in this mode, the heat budget model of the 2nd space is considered for the heat budget model of the 1st space like the expression 8 like the expression 7 among the space divided into two.
[0028]
[Mathematical formula 7]
Mr1 and dTr1/dt =alpha1(To1-Tr1)-beta1(Tr1-Tb1)+Qs1 Mb1 and dTb1/dt =beta1(Tr1-Tb1)-delta1(Tb1-Ta)+Qs2[0029]
[Mathematical formula 8]
Mr2 and dTr2/dt =alpha2(To2-Tr2)-beta2(Tr2-Tb2)+Qs3 Mb2 and dTb2/dt =beta2(Tr2-Tb2)-delta2(Tb2-Ta)+Qs4[0030]The differential equation showing the heat budget model which looked at the 1st equation of the expression 7 in the 1st space, and the 2nd equation are differential equations showing the heat budget model seen with the body by the side of the 1st space, The differential equation showing the heat budget model which looked at the 1st equation of the expression 8 in the 2nd space, and the 2nd equation are differential equations showing the heat budget model seen with the body by the side of the 2nd space.
[0031]The blow-off temperature of the air from which Ta expresses outside temperature and To1 blows off to the 1st space here, The room temperature of the 1st space detected by the room temperature sensor by which Tr1 is arranged in the 1st space, Tb1 the body temperature by the side of the 1st space, and Mr1 the calorific capacity of the 1st space, and Mb1 The body calorific capacity by the side of the 1st space, The quantity of heat and Qs2 which trespass upon the 1st space according [the heat transfer coefficient from the body by the side of the 1st space to the atmosphere and Qs1] to a solar radiation in delta 1 directly express the quantity of heat which the body [according / alpha 1 / to the amount of winds to the 1st space] by the side of the 1st space by a solar radiation according [beta 1] to the heat transfer coefficient from the 1st space to the body by the side of this space absorbs. The blow-off temperature of the air from which To2 blows off to the 2nd space, and Tr2 The room temperature of the 2nd space, Tb2 the body temperature by the side of the 2nd space, and Mr2 the calorific capacity of the 2nd space, and Mb2 The body calorific capacity by the side of the 2nd space, The quantity of heat and Qs4 which trespass upon the 2nd space according [the heat transfer coefficient from the body by the side of the 2nd space to the atmosphere and Qs3] to a solar radiation in delta 2 directly express the quantity of heat which the body [according / alpha 2 / to the amount of winds to the 2nd space] by the side of the 2nd space by a solar radiation according [beta 2] to the heat transfer coefficient from the 2nd space to the body by the side of this space absorbs.
[0032]If procession expression of the above-mentioned differential equation is carried out, it will become like the expression 9, and if this is rewritten, it will become an equation of state shown with the

expression 10. X1 (=[Tr1, Tb1] ^{T}) and X2 (=[Tr2, Tb2] ^{T}) are state variable vectors, and U1 (=[To1, Ta, Qs1, Qs2] ^{T}) and U2 (=[To2, Ta, Qs3, Qs4] ^{T}) are control input value vectors. The point estimate of the state variable of X1 presumed by the presumed model of the 1st space is set to Z1 (= [Tr1', Tb1'] ^{T}), When the point estimate of the state variable of X2 presumed by the presumed model of the 2nd space is set to Z2 (= [Tr2', Tb2'] ^{T}), the presumed model of each space is respectively expressed by the expression 11.

[0033]

[Mathematical formula 9]

$$\begin{bmatrix} \dot{Tr1} \\ \dot{Tb1} \end{bmatrix} = \begin{bmatrix} -\frac{\alpha 1+\beta 1}{Mr1} & \frac{\beta 1}{Mr1} \\ \frac{\beta 1}{Mb1} & -\frac{\beta 1+\delta 1}{Mb1} \end{bmatrix} \begin{bmatrix} Tr1 \\ Tb1 \end{bmatrix} + \begin{bmatrix} \frac{\alpha 1}{Mr1} & 0 & \frac{1}{Mr1} & 0 \\ 0 & \frac{\delta 1}{Mb1} & 0 & \frac{1}{Mb1} \end{bmatrix} \begin{bmatrix} To1 \\ Ta \\ Qs1 \\ Qs2 \end{bmatrix}$$

$$\begin{bmatrix} \dot{Tr2} \\ \dot{Tb2} \end{bmatrix} = \begin{bmatrix} -\frac{\alpha 2+\beta 2}{Mr2} & \frac{\beta 2}{Mr2} \\ \frac{\beta 2}{Mb2} & -\frac{\beta 2+\delta 2}{Mb2} \end{bmatrix} \begin{bmatrix} Tr2 \\ Tb2 \end{bmatrix} + \begin{bmatrix} \frac{\alpha 2}{Mr2} & 0 & \frac{1}{Mr2} & 0 \\ 0 & \frac{\delta 2}{Mb2} & 0 & \frac{1}{Mb2} \end{bmatrix} \begin{bmatrix} To2 \\ Ta \\ Qs3 \\ Qs4 \end{bmatrix}$$

[0034]

[Mathematical formula 10]

dX1/dt=A1, X1+B1, andU1 ... (1)

dX2/dt=A2, X2+B-2, andU2 ... (2)

Y1=Tinc=C1andX1[0035]

[Mathematical formula 11]dZ1/dt=A1, Z1+B1, andU1dZ2/dt=A2, Z2+B-2, andU2Y1'=C1andZ1 [0036] In order to complete the presumed error e1 (=X1-Z1) of a state variable as zero to the presumed model of the 1st space, As shown in drawing 1, feed back the error of Y1 (= Tinc) and Y1' (=Tr1'), and the observer of the 1st space is expressed like the expression 12, The correction amount of the amount of feedbacks applied to the observer of the 1st space is applied to the presumed model of the 2nd space, and the observer of the 2nd space is expressed like the expression 13.

[0037]
[Mathematical formula 12]dZ1/dt=A1, Z1+B1, andU1+K1 (Y1-Y1')
[0038]
[Mathematical formula 13]dZ2/dt=A2, Z2+B-2, U2+K2, andK1 (Y1-Y1')
[0039]It is determined beforehand that the presumed model of the 1st space will converge K1 here as mentioned above, and, [K2] It is a coefficient matrix which amends the presumed model of the 2nd space in consideration of the thermal correlation with the 1st space and the 2nd space, for example, is determined like the expression 14 using the heat transfer coefficient of the 1st space and the 2nd space.
[0040]
[Mathematical formula 14]

$$K2 = \begin{bmatrix} \beta 2/\beta 1 & 0 \\ 0 & \delta 2/\delta 1 \end{bmatrix}$$

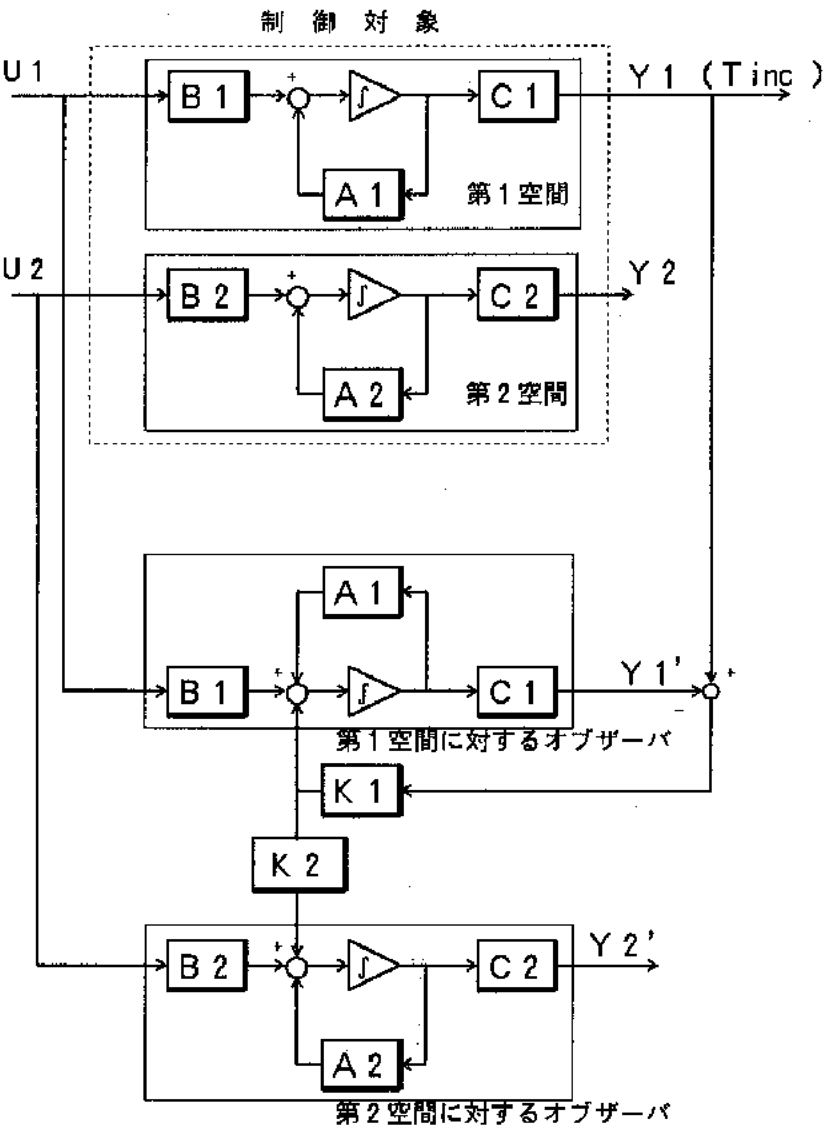
[0041]If it is in K1 when the determination technique of K1 and K2 is explained more concretely, since the presumed error e1 of a state variable is (X1-Z1), the expression 15 is obtained from the expression 10 (1)-expression 12.
[0042]
[Mathematical formula 15]
dX1/dt-dZ1/dt=A1(X1-Z1)-K1(Y1-Y1')
= A1(X1-Z1)-K1 and C1 (X1-Z1)
[0043]Here, from e=X1-Z1, the expression 15 becomes like the expression 16 (1), and this general solution is denoted by the expression 16 (2).
[0044]
[Mathematical formula 16]
de/dt=(A1-K1 and C1) e ... (1)
e=EXP(A1-K1 and C1) t ... (2)
[0045]Therefore, A1-K1 and C1 can complete e by choosing K1 used as negative suitably.
[0046]On the other hand, since it is explained in full detail as the observer shown by drawing 1 is first shown in drawing 2 if it is in the determination of K2, it explains based on this. If it assumes now that it is what the model of an observer is in agreement with an actual system, and the presumed error e depends on the error (for example, error by outside temperature) of a control input value, When it converts into the quantity of heat about the body by the side of the 1st space, the amount of corrections of an observer (=K1a (Tinc-Tr1)) is expressed like the expression 17 (1), therefore serves as the expression 17 (2).
[0047]
[Mathematical formula 17]
K1a(Tinc-Tr1') =Tb1'-beta1-/Mb1 ... (1)
Tb1'=K1a (Tinc-Tr1') and Mb1/beta 1 ... (2)
[0048]If the error by the side of the 2nd space has arisen now according to the same cause as the error by the side of the 1st space, what is necessary is just to carry out the correction quantity of heat of the 2nd space like the expression 18 (1) therefore, and K2a becomes like the expression 18 (2).
[0049]
[Mathematical formula 18]

Tb1' and beta2/Mb2= K1a (Tinc-Tr1') and Mb1/beta2 [beta1 and]/Mb2 ... (1)
K2a=Mb1andbeta2/beta1/Mb2 ... (2)
[0050]Similarly, the amount of corrections of an observer (=K1b (Tinc-Tr1')) is expressed like the expression 19 (1), and since the amount of corrections in this case is Ta'-delta2-/Mb2, if it calculates similarly, K2b will become like the expression 19 (2).
[0051]
[Mathematical formula 19]
K1b(Tinc-Tr1') =Ta'-delta1-/Mb1 ... (1)
K2b=Mb1anddelta2/delta1/Mb2 ... (2)
[0052]And depending on the method of division with the 1st space and the 2nd space, it may be set to Mb1**Mb2, for example, and K2 of drawing 1 is determined like the above-mentioned expression 14 in this case.
[0053]Therefore, the dynamic model corresponding to the 1st space of this invention is received, It is the same composition as the former to which correction is added based on the deviation of the degree of real temperature measurement (detection value) detected by the room temperature sensor formed in the 1st space, and its estimated temperature, and the physical quantity (room temperature Tr1 of the 1st space and body temperature Tb1 by the side of the 1st space) showing a dynamic internal state is presumed with sufficient accuracy. On the other hand, if it is in the dynamic model corresponding to the 2nd space, [be / if the amount of corrections was made the same as that of the amount of corrections to the dynamic model of the 1st space / in model accuracy / a problem] Since the amount of corrections to the dynamic model of the 1st space is multiplied by the coefficient matrix showing the thermal characteristic decided in the relation with other space and he is trying to correct the dynamic model of the 2nd space with this value by which it multiplied, The physical quantity (room temperature Tr2 of the 2nd space and body temperature Tb2 by the side of the 2nd space) showing the internal state of the dynamic model of the 2nd space can also be presumed with sufficient accuracy.
[0054]
[Effect of the Invention]As stated above, according to this invention, the vehicle interior of a room is divided into two or more control space, Based on the dynamic model of the system about air-conditioning of each space, carry out the optimal control of the air-conditioning control element, and each space is faced carrying out independent temperature control, To at least one dynamic model, add correction based on the deviation of the space temperature and presumed space temperature corresponding to the model, and other dynamic models are received, Since he is trying to add correction further in consideration of the thermal characteristic determined by the relation with the other space of the space corresponding to this, the estimation precision of physical quantity can be raised in each dynamic model, and accuracy can improve temperature control control in each divided vehicle indoor space. Since a room temperature sensor is not needed for every space, even if it is a case where independent temperature control control of each space is carried out, it becomes possible to correspond with few room temperature sensors.

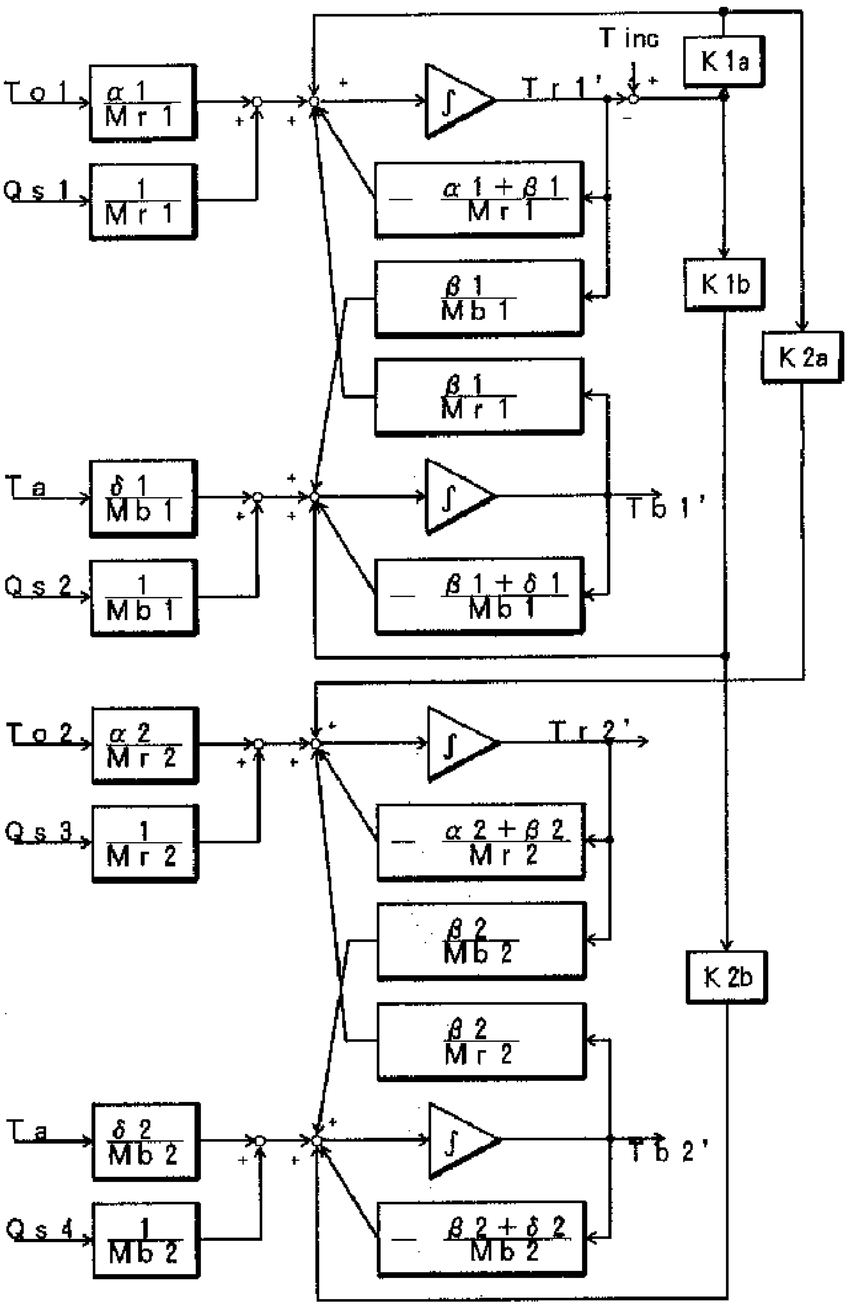
[Brief Description of the Drawings]
[Drawing 1]Drawing 1 is a block diagram showing the example of the observer used for the air-

conditioner for vehicles concerning this invention.
[Drawing 2]Drawing 2 is the block diagram which explained the observer in full detail further.
[Drawing 3]Drawing 3 is a functional block diagram showing all the system structure of the conventional air-conditioner for vehicles.
[Drawing 4]Drawing 4 is a block diagram showing the example of the conventional observer.
[Explanations of letters or numerals]
10 Air-conditioning unit
20 Norm model
30 Observer
40 Linear compensator
50 Optimal regulator

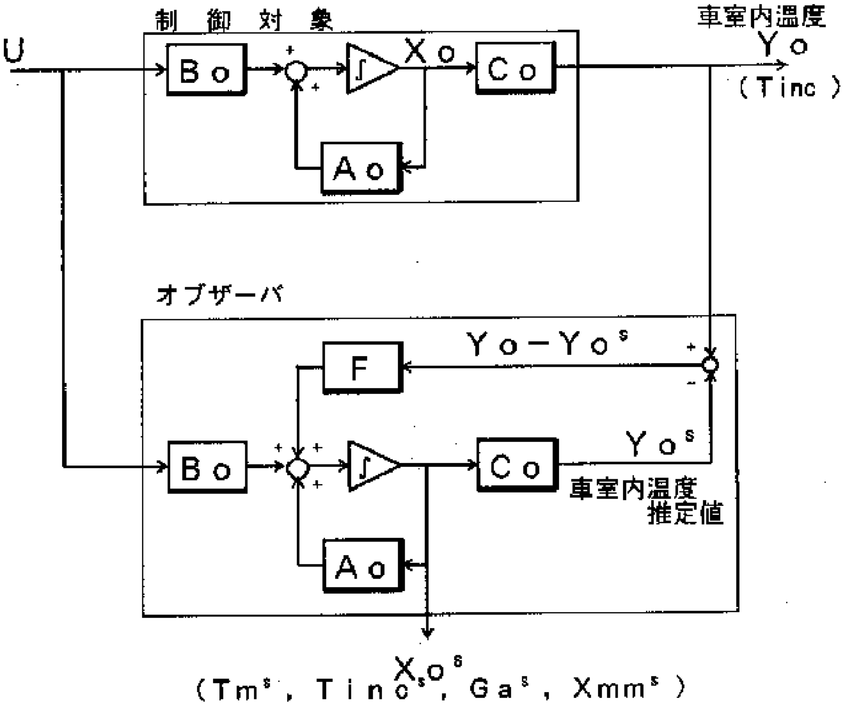
[Drawing 1]



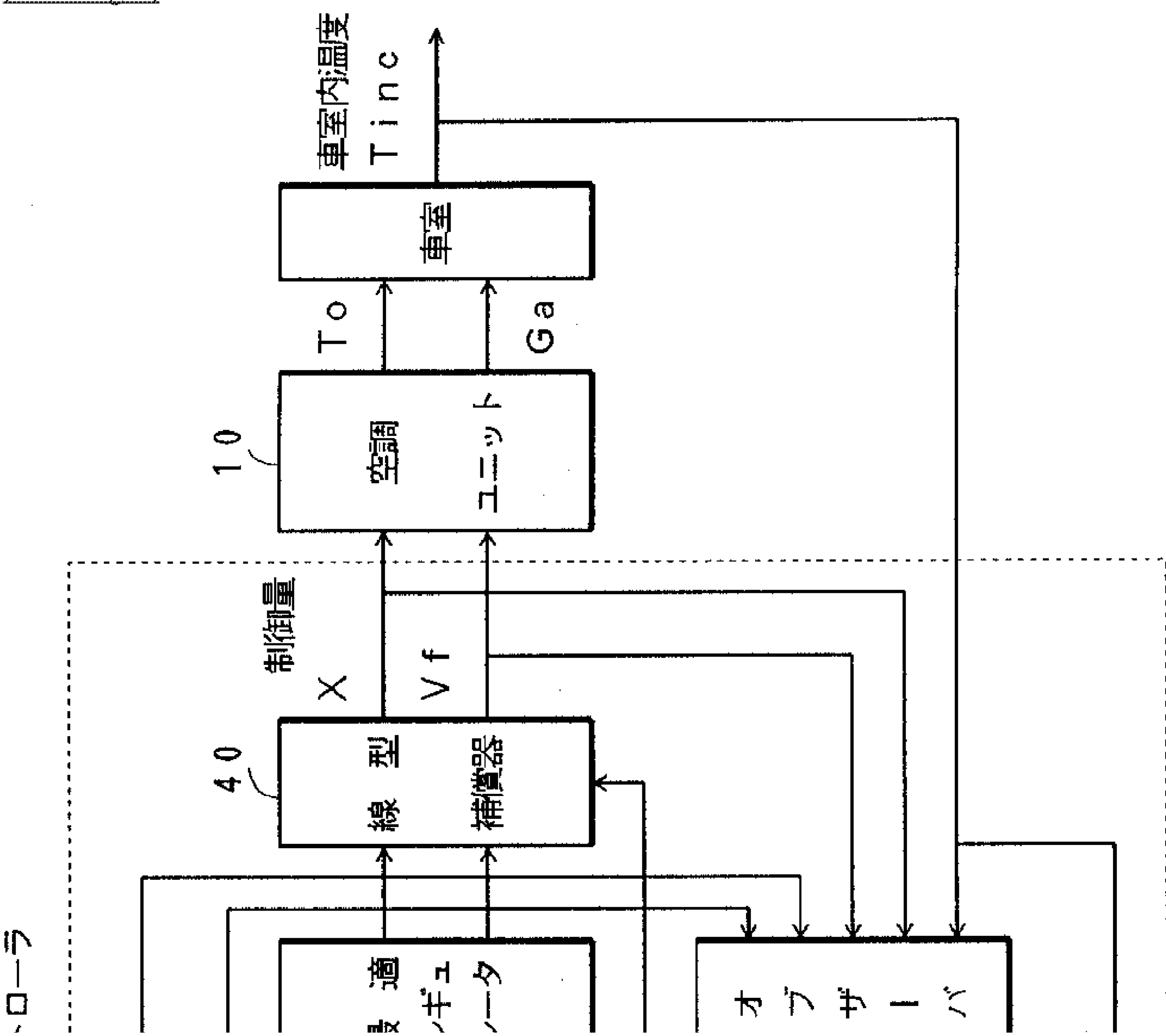
[Drawing 2]

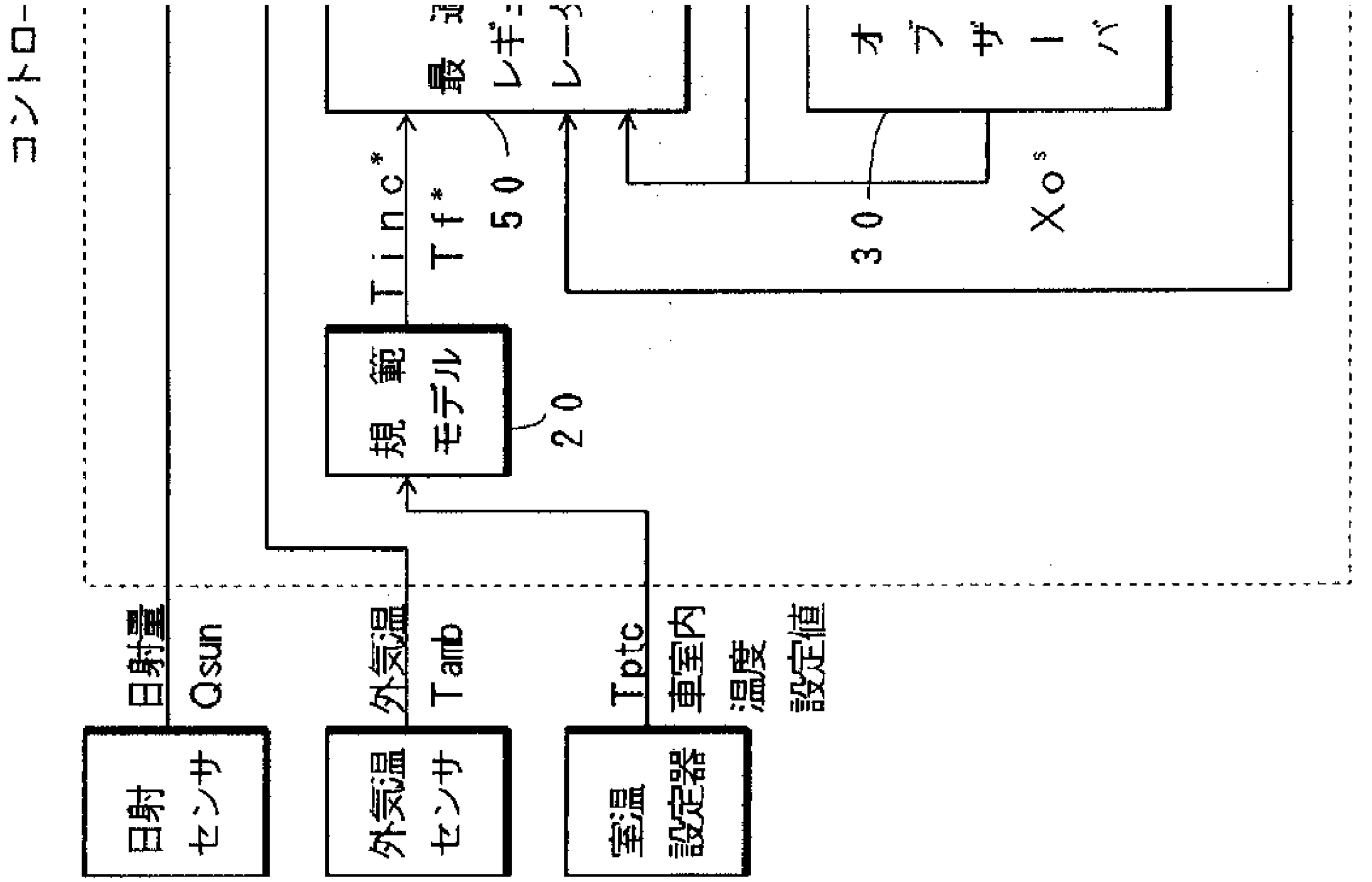


[Drawing 4]


制御対象
U
Bo
Xo
Co
Ao
車室内温度
Yo
(Tinc)
オブザーバ
F
Yo−Yo^s
Bo
Co
Yo^s
車室内温度推定値
Ao
Xo^s
(Tm^s, Tinc^s, Ga^s, Xmm^s)

[Drawing 3]


車室内温度
Tinc
車室
To
Ga
10
空調ユニット
制御量
X
Vf
40
線型補償器
オブザーバ



[Translation done.]